

# Does Political Alternation Reshape Solar-Stock Return Formation? Evidence from Taiwan's Energy Transition

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## Article

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# **Does Political Alternation Reshape Solar-Stock Return Formation? Evidence from Taiwan's Energy Transition**

## **Abstract**

This study examines whether political alternation is associated with changes in stock-return formation in Taiwan's policy-sensitive solar industry. Using monthly firm-level data for six listed companies from June 2008 to June 2024, we estimate linear panel models and a Hansen-type panel threshold model. International oil-price growth and lagged revenue growth are positively associated with solar-stock returns in the full sample. The endogenous threshold test does not reject linearity; accordingly, the conditional minimizing date of December 2020 is treated as exploratory rather than as evidence of a political-regime break. Descriptive later-period estimates show a negative revenue–return association, which is consistent with possible weakening in the conversion of revenue growth into expected profitability but does not establish a causal policy effect. Overall, the evidence does not identify a discrete change in the return-generating process attributable to political turnover alone. The study contributes to research on renewable-energy governance by distinguishing political alternation from policy implementation and by showing that capital-market responses depend on firms' ability to convert policy-supported expansion into sustainable cash flows.

**Keywords:** political alternation; renewable-energy governance; solar stocks; oil prices; revenue growth; panel threshold model; Taiwan

**JEL Classification:** G14; Q42; Q48; C23; P16

## **I. Introduction**

The relationship between political regimes and financial markets has garnered increasing attention, especially in sectors where public policy, infrastructure planning, and regulatory incentives shape long-term investment outcomes. Utility industries—such as energy, transportation, and water—are particularly sensitive to changes in political leadership and regulatory architecture. Prior studies show that firms with strong political ties tend to outperform when their affiliated party is in office (Ferguson & Voth, 2008; Goldman et al., 2009; Cooper et al., 2010; Belo et al., 2013). In Taiwan, Shen et al. (2016) found that politically connected firms often exhibit weaker internal controls, suggesting that policy access may substitute for governance quality. Similar evidence from Iran (Faraji et al., 2020) and Spain (Castaño et al., 2024) emphasize how market reactions to political transitions depend on institutional environments and regulatory stability.

Taiwan provides a relevant case study for understanding how political power transitions influence clean energy market dynamics. As a democratic country with alternating administrations between the Kuomintang (KMT) and the Democratic Progressive Party (DPP), Taiwan's energy policy has experienced sharp directional shifts. The KMT (2008–2016) maintained a pragmatic stance on nuclear energy and favored a gradual integration of renewables. In contrast, the DPP (since 2016) has prioritized green energy reform, committing to a full nuclear phase-out by 2025 and promoting solar capacity expansion through feed-in tariffs, rooftop PV deregulation, and public investment programs. These initiatives position the solar sector as a core element in Taiwan's long-term utility and infrastructure strategy.

Despite the DPP's policy ambitions and its framing of renewable energy as a vehicle for sustainability and industrial innovation (aligned with SDG 7 and SDG 9), the real-world economic effects of such reforms remain unclear. Media narratives and government communications often highlight the scale of solar installations and budgetary support; however, market performance indicators—such as stock returns of listed solar firms—provide a more objective lens through

which to evaluate whether these policy reforms have translated into investor confidence or structural transformation.

This study addresses a critical gap in the literature by empirically assessing whether Taiwan's solar energy firms experienced measurable changes in stock return behavior across political regimes. Unlike previous studies that focus on static political connections (e.g., Shen et al., 2016; Fang et al., 2020), we apply Hansen's (1999) panel threshold model to detect endogenous regime shifts in firm performance over time. This approach allows for a data-driven identification of structural changes, avoiding subjective assumptions about when political influence takes effect.

By doing so, our study contributes to the policy evaluation literature in three key ways. First, it provides evidence on the extent to which political alternation translates into effective policy implementation in the renewable energy domain. Second, it assesses whether clean energy transitions in democratic settings are accompanied by structural changes in utility market performance. Third, it informs broader discussions on how to design evidence-based performance metrics for energy policy reforms, particularly when national targets are aligned with global development goals such as SDG 7 (Affordable and Clean Energy) and SDG 9 (Industry, Innovation and Infrastructure).

To test these questions, we formulate three hypotheses:

H1: International oil-price changes are positively associated with solar-stock returns.

H2: Lagged firm-level revenue growth contains valuation-relevant information for solar-stock returns.

H3: A statistically identifiable structural change in the revenue–return relationship coincides with or follows the 2016 political alternation.

The remainder of the paper is structured as follows. Section II develops the valuation framework, describes the data, and presents the empirical strategy. Section III reports the baseline,

threshold, and identification-sensitivity results. Section IV discusses the findings in relation to renewable-energy governance and capital-market valuation. Section V concludes.

## II. Methodology

### A. Theoretical Framework

This study develops a valuation-based framework to explain the relationship among international oil prices, firm-level revenue growth, political regime conditions, and solar energy stock returns. The theoretical model is designed to provide an economic foundation for the existing linear panel and panel threshold specifications without introducing additional explanatory variables. The market value of solar energy firm  $i$  at time  $t$  can be expressed as the discounted value of its expected future cash flows: This valuation logic is consistent with the accounting-based equity valuation framework of Ohlson (1995).

$$P_{it} = E \left[ \sum_{h=1}^{\infty} \frac{CF_{i,t+h}}{(1+k_{it})^h} \right] \quad (1)$$

where  $P_{it}$  denotes the firm's stock price,  $CF_{i,t+h}$  represents future operating cash flows, and  $k_{it}$  is the required rate of return. For analytical convenience, the valuation equation may be approximated by a constant-growth model:

$$P_{it} = \frac{E_t(CF_{i,t+1})}{k_{it} - g_{it}} \quad (2)$$

where  $g_{it}$  denotes the expected long-term growth rate of firm cash flows. Equation (2) implies that stock prices increase with expected cash flows and decrease with the discount rate applied by investors. Operating cash flow can be expressed as the product of firm revenue and the effective operating margin:

$$CF_{i,t+1} = M_{i,t+1} RV_{i,t+1} \quad (3)$$

where  $M_{i,t+1}$  denotes firm revenue and  $RV_{i,t+1}$  measures the proportion of revenue converted into operating cash flow. Consequently, prior-period revenue provides investors with information about future operating performance. Because monthly revenue is publicly disclosed with a short

reporting lag, investors may use the previous month's revenue growth to revise their expectations of future cash flows. Expected cash flows are assumed to depend on international oil prices and lagged firm revenue:

$$\ln E_t(CF_{i,t+1}) = a_i + \eta_0 \ln OP_t + \eta_r(s_t) \ln RV_{i,t-1} + u_{it} \quad (4)$$

where  $OP_t$  denotes the international crude oil price,  $a_i$  captures firm-specific characteristics, and  $s_t$  represents the prevailing political and institutional state. The parameter  $\eta_0$  measures the elasticity of expected cash flow with respect to oil prices, whereas  $\eta_r(s_t)$  measures the state-dependent valuation elasticity of lagged revenue.

An increase in international oil prices raises the relative attractiveness of alternative energy sources. Higher conventional energy prices may increase expected demand for renewable energy investment and improve investor sentiment toward solar energy firms. Therefore, the oil-price elasticity is expected to be positive:

$$\eta_0 > 0$$

The effect of revenue growth on firm value depends on the extent to which additional revenue is translated into expected cash flow. Taking logarithms of Equation (3) yields:

$$\ln CF_{i,t+1} = \ln M_{i,t+1} + \ln RV_{i,t+1} \quad (5)$$

The elasticity of cash flow with respect to revenue is therefore:

$$\eta_r(s_t) = \partial \ln E_t(CF_{i,t+1}) / \partial \ln RV_{i,t-1} = \rho_i + \phi(s_t). \quad (6)$$

$$\rho_i = \frac{\partial \ln E_t(RV_{i,t+1})}{\partial \ln RV_{i,t-1}} > 0, \phi(s_t) = \frac{\partial \ln E_t(M_{i,t+1})}{\partial \ln RV_{i,t-1}}$$

Under normal operating conditions, revenue growth signals stronger demand and improved future cash flows, implying  $\eta_r(s_t) > 0$ . However, the revenue effect may weaken when revenue expansion is accompanied by declining margins, severe price competition, excess capacity, rising production costs, or policy-induced low-margin projects. If the decline in the effective operating margin is sufficiently large, the valuation effect of revenue growth may become zero or negative.

This mechanism provides a theoretical explanation for a possible decoupling between revenue growth and stock returns without requiring additional variables in the empirical model.

Political alternation is assumed to influence the mapping from firm revenue to expected cash flow rather than necessarily exerting an unconditional direct effect on stock returns. Differences in renewable energy policy, regulatory stability, policy credibility, and implementation effectiveness may alter the informational content of revenue growth. Accordingly, the revenue elasticity is allowed to differ across institutional states:

$$\eta_r(s_t) = \eta_{r1}I(q_t \leq \gamma) + \eta_{r2}I(q_t > \gamma) \quad (7)$$

where  $q_t$  is the time threshold variable,  $\gamma$  is the unknown threshold value, and  $I(\cdot)$  is an indicator function. If policy support strengthens the persistence and profitability of firm revenue, then  $\eta_{r2} > \eta_{r1}$ . Conversely, if policy-driven expansion leads to lower revenue quality or margin compression, then  $\eta_{r2} < \eta_{r1}$ , and the coefficient may even become negative.

Substituting Equation (4) into the valuation equation and taking first differences yields:

$$\Delta \ln P_{it} = \eta_0 \Delta \ln OP_t + \eta_r(s_t) \Delta \ln RV_{i,t-1} - \Delta \ln(k_{it} - g_{it}) + \Delta u_{it}$$

$$\varepsilon_{it} = -\Delta \ln(k_{it} - g_{it}) + \Delta u_{it}$$

Defining stock returns, oil-price growth, and revenue growth as

$$rst_{it} = \Delta \ln P_{it}$$

$$opg_t = \Delta \ln OP_t$$

$$rvg_{i,t-1} = \Delta \ln RV_{i,t-1}$$

$$rst_{it} = \mu_i + \beta_0 opg_t + \beta_r rvg_{i,t-1} + \varepsilon_{it} \quad (8)$$

The theoretical predictions are:

$$\beta_0 > 0$$

and, under normal operating conditions,

$$\beta_r > 0$$

To examine whether the valuation relevance of revenue changes across political and institutional

states, Equation (8) is extended to the panel threshold specification:

$$rst_{it} = \mu_i + \beta_0 opg_t + \beta_{r1} rvg_{i,t-1} I(q_t \leq \gamma) + \beta_{r2} rvg_{i,t-1} I(q_t > \gamma) + \varepsilon_{it} \quad (9)$$

The null hypothesis of no threshold effect is:

$$H_0: \beta_{r1} = \beta_{r2}$$

whereas the alternative hypothesis is:

$$H_1: \beta_{r1} \neq \beta_{r2}$$

Under this framework, the absence of a statistically significant threshold does not imply that political alternation has no economic relevance. Instead, it indicates that the institutional transition was not sufficiently strong or homogeneous to generate a statistically identifiable change in the relationship between revenue information and stock returns. The model therefore accommodates both the positive full-sample effects and the weaker or negative revenue coefficient observed in the later subsample while remaining fully consistent with the empirical specifications adopted in this study.

## B. Data Description

This study focuses on listed solar energy companies in Taiwan to examine whether their stock returns differ significantly across political regimes—namely, the Kuomintang (KMT) and the Democratic Progressive Party (DPP) administrations. Because most offshore wind energy companies and pure electricity retailers in Taiwan emerged only after the DPP came to power in 2016, they are excluded from our empirical analysis to ensure adequate data coverage and consistency.

To construct a longitudinal panel, we selected six publicly traded firms with sufficiently long and comparable photovoltaic-related histories between June 2008 and June 2024. Listing dates, mergers, suspensions, and data availability differ across firms; consequently, the estimation sample is an unbalanced monthly panel. Firm histories and inclusion criteria were checked against

public company disclosures and Taiwan Stock Exchange or Taipei Exchange records. Table 1 summarizes the selected firms and their principal activities.

Table 1. Overview of Selected Solar Energy Firms in Taiwan

| Company Name                        | Ticker Code | Business Description                                                               |
|-------------------------------------|-------------|------------------------------------------------------------------------------------|
| Gigastorage Corporation             | 2406.TW     | Manufacturer and distributor of solar silicon wafers and optical disc materials    |
| United Renewable Energy Co., Ltd.   | 3576.TW     | Producer of solar cells, modules, and integrated solar power systems               |
| Danen Technology Corporation        | 3686.TW     | Manufacturer and retailer of electronic and photovoltaic materials                 |
| Giga Solar Materials Corporation    | 3691.TWO    | Developer of conductive pastes for solar cell applications (e.g., silver/aluminum) |
| Sino-American Silicon Products Inc. | 5483.TWO    | Producer of solar ingots, wafers, cells, and system-level solutions                |
| Motech Industries Inc.              | 6244.TWO    | Developer of high-efficiency solar cells and photovoltaic systems                  |

Source: Authors' compilation based on public company disclosures and Taiwan Stock Exchange records.

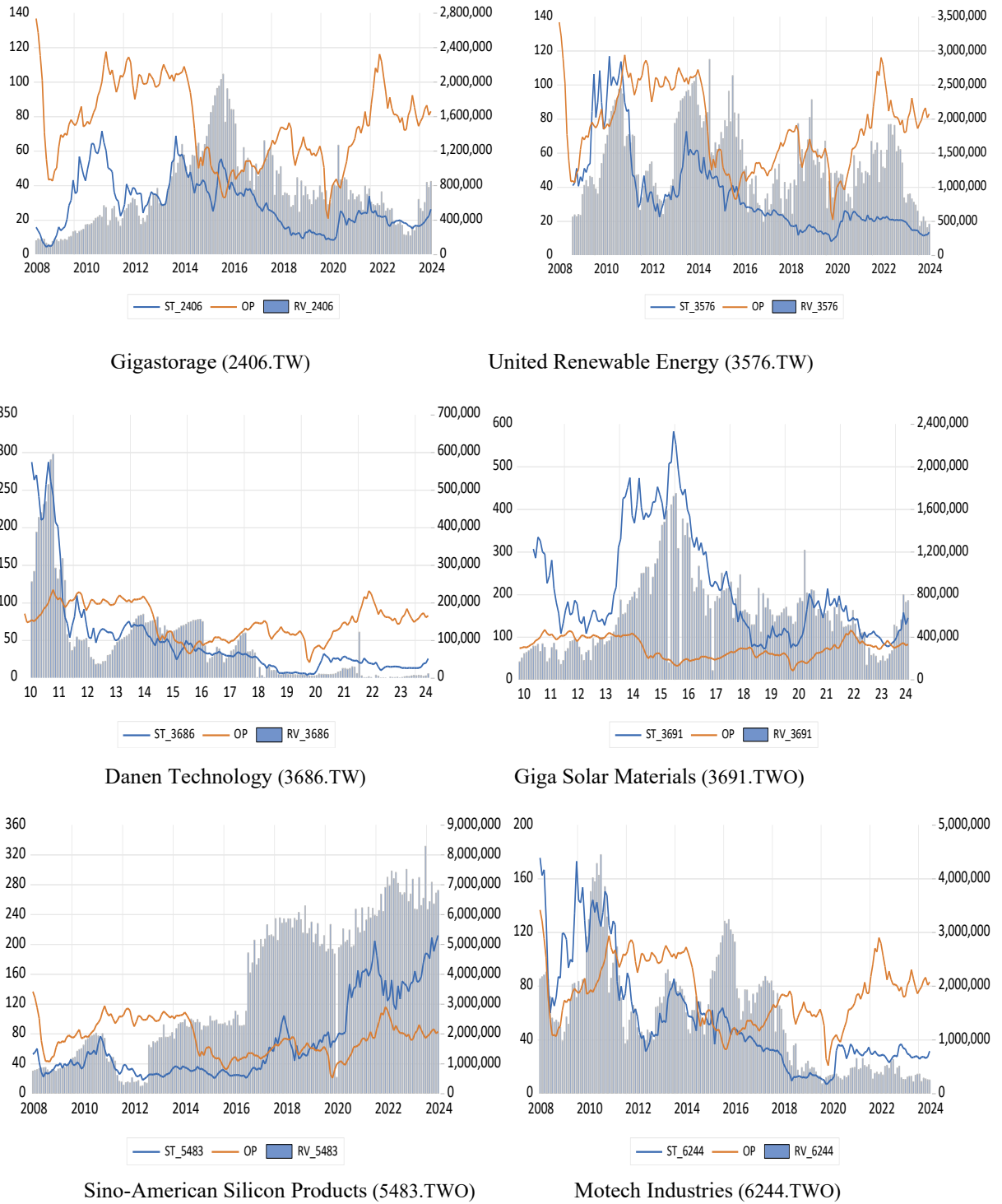


Fig. 1. Trends in Stock Prices (ST), Oil Prices (OP), and Monthly Revenue (RV)

Notes: This figure illustrates the time-series movements of monthly average stock prices (ST), international crude oil prices (OP), and company-level monthly revenue (RV) from June 2008 to June 2024 for the six selected solar energy firms in Taiwan. The stock and revenue data are log-transformed and differenced to ensure stationarity. The chart reveals a generally positive co-movement between stock and oil prices, with revenue trends diverging across firms after 2021.

Source: Authors' calculations based on data from Taiwan Economic Journal (TEJ), Yahoo Finance, and the Market Observation Post System.

Fig. 1 presents the time-series trends of three key variables: monthly stock prices (ST) of solar energy firms, international crude oil prices (OP), and firm-level monthly revenue (RV), over the sample period from June 2008 to June 2024. There appears to be a positive co-movement between oil prices and solar stock prices, suggesting that rising oil prices may enhance the relative attractiveness of alternative energy investments. Similarly, revenue trends exhibit a broadly positive correlation with stock performance.

However, after 2021, a divergence is observed across firms. Specifically, aside from Sino-American Silicon Products and United Renewable Energy, most companies in the sample display a downward trend in monthly revenue. This heterogeneity complicates the interpretation of linear relationships, as the strength and direction of correlation among the three variables—stock price (ST), oil price (OP), and revenue (RV)—appear to be less consistent during the later period.

The panel dataset consists of monthly observations of these three variables. Stock price and revenue data were obtained from the Taiwan Economic Journal (TEJ) and the Market Observation Post System, while oil price data were sourced from Yahoo Finance (<https://finance.yahoo.com>). All time series were log-transformed and first-differenced to ensure stationarity before model estimation.

### C. Methodology

Panel data models offer multiple advantages as outlined by Hsiao (2003). These include: (i) accounting for individual heterogeneity by capturing firm-specific effects, (ii) modeling dynamic behavior across time, (iii) increasing the number of observations, thereby improving estimation efficiency, and (iv) reducing omitted variable bias by controlling for both cross-sectional and temporal fixed effects. These features make panel data suitable for examining firm performance across political and economic regimes.

The general linear specification is given by:

$$y_{it} = \alpha + \mu_i + x'_{it}\beta + \varepsilon_{it}, \quad i=1,2,3,\dots,N \quad t=1,2,3,\dots,T \quad (10)$$

In eq.(10), where  $y_{it}$  denotes the stock return of solar firm  $i$  at time  $t$ ,  $x_{i,t}$  is a vector of explanatory variables including lagged revenue growth and changes in crude oil prices (averaged from WTI and Brent),  $\mu$  is the constant term,  $\beta$  is the coefficient vector, and  $e_{it}$  is the error term.

Given the extended observation period (2008–2024) that spans two distinct political regimes, structural nonlinearity is likely over time. To account for such potential nonlinear effects, we apply the panel threshold model (PTM) developed by Hansen (1999), where the threshold variable is time (i.e., calendar date), and the model allows for different slope coefficients before and after the threshold.<sup>1</sup> This treatment complements classical and unknown-break structural-change tests (Chow, 1960; Andrews, 1993; Andrews & Ploberger, 1994) and multiple-break procedures (Bai & Perron, 1998, 2003a, 2003b).

Following Hansen (1999), the single-threshold panel model is specified as follows:

$$y_{it} = \mu_i + \beta_1' x_{it} I(q_{it} \leq \gamma) + \beta_2' x_{it} I(q_{it} > \gamma) + \varepsilon_{it} \quad (11)$$

Where  $q_{it}$  is the threshold variable,  $\gamma$  is the threshold value to be estimated, and  $I(\cdot)$  is an indicator function. Let  $x_{it}(\gamma)$  denote the regime-specific regressors. The model can be rewritten as:

$$y_{it} = \mu_i + \beta' x_{it}(\gamma) + e_{it} \quad (12)$$

Applying the within transformation (group-mean deviation), we obtain:

$$Y^* = X^*(\gamma)\beta + e^* \quad (13)$$

The residual sum of squares for a given threshold  $\gamma$  is:

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<sup>1</sup> To reduce the complexity of the empirical estimation process, Hansen (1999) proposed a transformation based on the "within-group mean deviation" approach. The within transformation eliminates time-invariant firm-specific effects. It does not, by itself, resolve endogeneity arising from simultaneity, measurement error, or omitted time-varying variables.

$$S_1^*(\gamma) = \sum_{i,t} (\hat{e}_{it}^*(\gamma))^2$$

The optimal threshold estimate  $\gamma$  minimizes the residual sum of squares over all possible values:

$$\hat{\gamma} = \arg \min_{\gamma} S_1^*(\gamma) \quad (14)$$

Once the optimal threshold is obtained, its corresponding residual variance is computed, and statistical inference is conducted to test for the existence of threshold effects: Null hypothesis (no threshold):

$$H_0: \beta_1 = \beta_2 \quad (15)$$

The likelihood ratio (LR) statistic is computed and compared to simulated critical values using bootstrapping. If a significant threshold is found, the procedure may be repeated to search for additional breakpoints, allowing the estimation of multi-threshold models and further exploration of nonlinear dynamics across regimes. This flexible modeling approach enables us to endogenously identify structural breaks without imposing subjective regime splits (e.g., manually separating KMT and DPP periods), offering a more robust assessment of whether political alternation causes statistically significant changes in solar firm stock dynamics.

### III. Empirical Results and Economic Implications

#### A. Empirical Results

This study utilizes three monthly frequency variables: stock prices (ST), international crude oil prices (OP), and firm-level revenue (RV). To avoid the issue of spurious regression, we transform all variables by applying a natural logarithm and then taking the first-order difference. The resulting series are: stock return rate  $rst$ , oil price growth rate  $opg$ , and revenue growth rate  $rvg$ . In our panel data model,  $rst$  is the dependent variable, while  $opg$  and lagged  $rvg$  are key explanatory variables.

We conduct panel unit root tests to confirm the differenced series' stationarity. As shown in Table 2, all three variables reject the null hypothesis of a unit root under multiple testing procedures—including the Levin, Lin & Chu t-test, the Im, Pesaran and Shin W-stat, and Fisher-type ADF and PP tests. These results confirm that the transformed series are stationary and suitable for panel data modeling.

Table 2. Panel unit roots of variables

| Methods                                                   | rst        | opg        | rvg        |
|-----------------------------------------------------------|------------|------------|------------|
| Null: Unit root<br>(assumes common unit root process)     |            |            |            |
| Levin, Lin & Chu t* test                                  | -33.695*** | -24.001*** | -43.783*** |
| Null: Unit root<br>(assumes individual unit root process) |            |            |            |
| Im, Pesaran and Shin W-stat test                          | -32.435*** | -21.425*** | -42.208*** |
| ADF - Fisher Chi-square test                              | 560.127*** | 365.341*** | 627.007*** |
| PP - Fisher Chi-square test                               | 560.741*** | 337.078*** | 602.225*** |

Note: The notation '\*\*\*' implies statistical significance at the 1% level. Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

Source: Authors.

Based on the linear panel data framework and after model selection, the preferred empirical specification is as follows:

$$rst_{i,t} = a_0 + a_1 opg_{i,t} + a_2 rvg_{i,t-1} + e_{i,t} \quad (16)$$

Where  $rst_{i,t}$  denotes the monthly stock return of firm  $i$  at time  $t$ ,  $opg_{i,t}$  represents the growth rate of international crude oil prices,  $rvg_{i,t-1}$  refers to the one-month lagged growth rate of firm revenue, and  $e_{i,t}$  is the error term. The parameters  $a_0$ ,  $a_1$  and  $a_2$  are to be estimated. To determine whether a fixed effects or random effects model is more appropriate, we conduct the Hausman test. The results are shown in Table 3.

Table 3. Hausman Test Results

| Correlated Random Effects - Hausman Test |                   |              |         |
|------------------------------------------|-------------------|--------------|---------|
| Test cross-section random effects        |                   |              |         |
| Test Summary                             | Chi-Sq. Statistic | Chi-Sq. d.f. | P-value |
| Cross-section random                     | 2.295             | 2            | 0.317   |

Note: The null hypothesis cannot be rejected at conventional significance levels, implying that the random effects model is preferable.

Source: Authors' calculations using EViews software.

Before estimating the parameters of the linear panel data model, determining whether a fixed effects (FE) or random effects (RE) specification is essential. To this end, we conducted a Hausman test, as shown in Table 3. The test statistic is 2.295 with a p-value of 0.317, which exceeds the 5% significance level. Thus, we fail to reject the null hypothesis, suggesting that the random effects model is preferred for our estimation.

Table 4 presents the estimation results using the full sample under the random effects specification. The results indicate that solar energy companies' stock returns (rst) are positively and significantly associated with international oil price growth (opg). The lagged revenue growth (rvlg) also exhibits a positive relationship with stock returns, which is significant at the 10% level. These findings are consistent with economic intuition and previous studies (e.g., Lee et al., 2019). In particular, rising oil prices enhance the attractiveness of alternative energy sources such as solar power, thereby increasing stock valuations. Similarly, positive revenue growth in the previous month signals improved fundamentals, likely boosting investor confidence and stock performance.

The lower panel of Table 4 presents the estimation results for two sub-samples. These results are broadly consistent with the full-sample outcomes, with one key difference: the effect of lagged revenue growth on stock returns varies. In the first sub-period (left panel), lagged revenue growth has a positive and statistically significant impact on stock returns (at the 10% level). In contrast, although the coefficient remains positive during the second sub-period (right panel), it is no longer statistically significant.

Table 4. Estimation Results of Linear Panel Data Models

|                                                    |             |             |                                           |         |
|----------------------------------------------------|-------------|-------------|-------------------------------------------|---------|
| Period: 2008M08 – 2024M06 (full sample)            |             |             |                                           |         |
| Method: Pooled EGLS (Cross-section random effects) |             |             |                                           |         |
| Cross-sections included: 6                         |             |             |                                           |         |
| Total pool (unbalanced) observations: 1086         |             |             |                                           |         |
| Swamy and Arora's estimator of component variances |             |             |                                           |         |
| Variable                                           |             | Coefficient |                                           | P-value |
| C                                                  |             | -0.003      |                                           | 0.447   |
| $opg_{i,t}$                                        |             | 0.216       |                                           | 0.000   |
| $rvg_{i,t}$                                        |             | 0.021       |                                           | 0.076   |
| 2008M08 2016M05 (sub-sample)                       |             |             | 2016M06 2024M06 (sub-sample)              |         |
| Total pool (unbalanced) observations: 510          |             |             | Total pool (unbalanced) observations: 576 |         |
| Variable                                           | Coefficient | P-value     | Coefficient                               | P-value |
| C                                                  | -0.004      | 0.572       | -0.004                                    | 0.466   |
| $opg_{i,t}$                                        | 0.268       | 0.001       | 0.186                                     | 0.000   |
| $rvg_{i,t}$                                        | 0.047       | 0.065       | 0.013                                     | 0.328   |

**Notes:** The dependent variable is the monthly stock return of solar energy firms ( $rst_{(i,t)}$ ). Estimates are based on panel data for six listed solar energy companies in Taiwan. The revenue variable ( $rvg$ ) is lagged by one period. The subsample period 2008M08–2016M05 corresponds to the KMT administration, and 2016M06–2024M06 to the DPP administration. All values are estimated using EViews software.

The division of these sub-periods is based on the alternation of ruling parties (KMT and DPP), a decision that may be considered somewhat subjective. We estimate a nonlinear panel data model using a threshold approach to address this potential bias and objectively assess whether a structural break exists over time. This allows the data to endogenously determine if and when a regime shift occurred.

When the sample period spans an extended timeframe or includes significant external shocks—such as the 2008 global financial crisis, the 2020 COVID-19 pandemic, or the Russia–Ukraine conflict—it is prudent to test for structural changes in the model. Failing to account for such breaks can result in biased or misleading estimates.

Our sample spans 16 years in this study, covering two consecutive eight-year terms under different ruling parties: the KMT and the DPP. Notably, following the inauguration of President Tsai, the government strongly promoted green energy policies, especially in solar power

development, which may have introduced nonlinear dynamics between firm fundamentals and stock returns. To investigate this, we adopt the Panel Threshold Model (PTM) framework proposed by Hansen (1999), with time (in monthly frequency) specified as the threshold variable to capture potential regime shifts.

The general specification of the PTM is given as follows:

$$rst_{it} = \alpha_i + \beta_0 opg_t + \beta_{r1} rvg_{i,t-1} I(q_t \leq \gamma) + \beta_{r2} rvg_{i,t-1} I(q_t > \gamma) + \varepsilon_{it}. \quad (17)$$

In the Panel Threshold Model (PTM) specification, the linear component includes the monthly growth rate of international crude oil prices. Conversely, the nonlinear component is represented by the lagged monthly revenue growth rate of solar energy companies. This revenue data is typically disclosed by the 10th of each month and is regarded as highly informative by stock market investors. The threshold variable in the PTM is defined as time, measured at a monthly frequency, which allows for regime differentiation based on structural changes over time. The whole sample period spans 16 years (from 2008 to 2024), covering the alternating administrations of the Kuomintang (KMT) and the Democratic Progressive Party (DPP), two major political parties in Taiwan with distinct energy policy orientations.

Where  $rst_{i,t}$  is the stock return,  $opg_{i,t}$  is the oil price growth,  $rvg_{i,t-1}$  is the lagged revenue growth, and  $TV_{i,t-1}$  denotes the threshold variable (time). The model allows for different coefficients  $b_1$  and  $b_2$  in two regimes separated by an unknown threshold time  $t$ .

To assess the necessity of this nonlinear specification, we perform a formal test for threshold effects. The null hypothesis posits no threshold (i.e., a linear model suffices), while the alternative suggests the existence of at least one threshold.

Table 5 summarizes the results of the single-threshold test. The likelihood ratio (LR) statistic is 10.576 with a p-value of 0.267. This value falls below the 10%, 5%, and 1% critical values, indicating that we cannot reject the null hypothesis of no threshold effect. Therefore, the model

does not support a statistically significant regime change, and a single linear model specification appears sufficient. This result prevents further tests for multiple thresholds (e.g., double vs. single threshold).

Table 5. Summary of Single Threshold Effect Test Results

| Method                                   | Statistics         |
|------------------------------------------|--------------------|
| LR Test for threshold effect             |                    |
| H <sub>0</sub> : No threshold effect     | 10.576             |
| H <sub>1</sub> : Single threshold effect | (0.267)            |
| Threshold value: 2020.12                 |                    |
|                                          | The critical value |
|                                          | 10% 12.989         |
|                                          | 5% 13.851          |
|                                          | 1% 17.529          |

Note: Results are based on Hansen's thresh\_p. R code executed in R. Values in parentheses represent p-values. Because the panel contains only six firms and the threshold variable is common across firms, the bootstrap inference should be interpreted cautiously. The threshold estimates are therefore supplemented by linear and exploratory subsample evidence.

**Source:** Authors' calculations.

Conditional on the single-threshold alternative, the residual sum of squares is minimized at December 2020. However, the bootstrap test is statistically insignificant ( $p = 0.267$ ), so this date cannot be interpreted as an identified structural break or as evidence of a DPP-specific regime. For descriptive purposes only, Table 6 reports subsample estimates around the conditional minimizing date. These estimates are not used to test H3 and should not be interpreted causally.

Figure 2 compares the reported single-threshold LR statistic with the bootstrap critical values. The statistic (10.576) is below the 10%, 5%, and 1% critical values, so the null hypothesis of no threshold effect cannot be rejected. The conditional RSS-minimizing date of December 2020 is therefore retained only as an exploratory partition and not as a statistically identified structural or political-regime break.

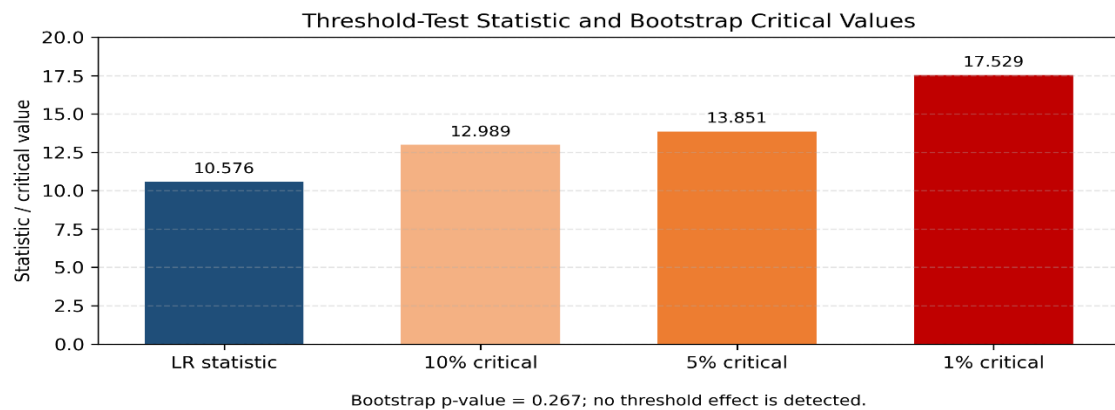


Fig. 2. Threshold-Test Statistic and Bootstrap Critical Values

Notes: The reported LR statistic is 10.576. Bootstrap critical values are 12.989 at 10%, 13.851 at 5%, and 17.529 at 1%. Because the test statistic is below every critical value, the null hypothesis of no threshold effect cannot be rejected. December 2020 is the conditional RSS-minimizing date under the threshold alternative, not a statistically identified break. Source: Authors' calculations.

Table 6 reports exploratory estimates around the conditional RSS-minimizing date. In the earlier subsample, oil-price changes and lagged revenue growth are positive and statistically significant. In the later subsample, their coefficients become negative, with the revenue coefficient statistically significant. Because the threshold test does not reject linearity, these differences describe sample variation and do not establish a structural or political-regime effect.

The later-period negative revenue coefficient may reflect margin compression, excess capacity, changing product composition, or global disruptions. These mechanisms remain interpretations rather than identified explanations because profitability and policy-implementation variables are not included in the baseline model.

The full-sample results show that oil-price growth is positively and statistically associated with solar-stock returns. Lagged revenue growth is also positive but statistically weaker, reaching significance at the 10% level. The results therefore support H1 and provide comparatively weaker evidence in favor of H2.

Table 6. Exploratory Subsample Estimates Based on the Conditional Minimizing Date of 2020M12

| Method: Pooled EGLS (Cross-section random effects) |             |         |                                           |         |
|----------------------------------------------------|-------------|---------|-------------------------------------------|---------|
| Swamy and Arora's estimator of component variances |             |         |                                           |         |
| 2008M08 2020M12 (sub-sample)                       |             |         | 2021M01 2024M06 (sub-sample)              |         |
| Total pool (unbalanced) observations: 834          |             |         | Total pool (unbalanced) observations: 252 |         |
| Variable                                           | Coefficient | P-value | Coefficient                               | P-value |
| C                                                  | -0.003      | 0.570   | -0.001                                    | 0.858   |
| opg <sub>it</sub>                                  | 0.251       | 0.000   | -0.019                                    | 0.843   |
| rvg <sub>it-1</sub>                                | 0.048       | 0.002   | -0.037                                    | 0.021   |

Note: opg<sub>it</sub> is the monthly return of international crude oil prices; rvg<sub>it-1</sub> is the one-month lagged growth rate of firm revenue. The sample sizes are 834 (left) and 252 (right). Estimations performed using EViews software. Because the threshold test is statistically insignificant, these estimates are descriptive and should not be interpreted as evidence of an identified structural break.

**Source:** Authors' calculations.

The endogenous threshold test does not identify a statistically significant structural change that coincides with or follows the 2016 political alternation. The conditional RSS-minimizing date of December 2020 is statistically insignificant and cannot be interpreted as an identified political-regime break. Accordingly, the evidence does not support H3.

Although the DPP administration placed greater policy emphasis on renewable energy, the reported stock-return evidence does not identify a common change in the valuation process across the sampled firms. This finding concerns capital-market transmission and should not be interpreted as a comprehensive evaluation of renewable-energy policy effectiveness.

The findings differ from Lee et al. (2019), which may reflect differences between political connections and sector-wide policy exposure, continuity in renewable-energy support across administrations, heterogeneous implementation lags, or omitted global and firm-specific shocks. These competing explanations motivate the identification cautions discussed below.

## B. Identification and Robustness Considerations

The threshold result is evaluated conservatively because the panel contains only six firms and the threshold variable is common across firms. The bootstrap p-value of 0.267 does not support a

discrete break. The conditional 2020 estimates are therefore supplementary descriptions rather than confirmatory evidence.

H3 is evaluated by searching for a statistically identifiable time threshold that coincides with or follows the 2016 political alternation. The bootstrap threshold test does not reject linearity; hence, the reported procedure provides no statistical support for H3. This finding is not proof that the 2016 alternation had no effect, because the procedure searches over candidate dates rather than directly testing a post-2016 interaction. The separate KMT- and DPP-period coefficients in Table 4 are descriptive and are not interpreted as a formal coefficient-difference test.

The estimates may also reflect common market shocks because the baseline specification does not include market returns, interest rates, exchange rates, or time fixed effects. The small cross-sectional dimension further limits formal treatment of cross-sectional dependence. These limitations mean that the findings should be interpreted as evidence of association and structural stability within the reported model rather than as causal estimates of political effects.

### **C. Economic Implications and Policy Recommendations**

The empirical findings yield several economic insights. First, the positive oil-price coefficient is consistent with a market-perceived linkage between conventional-energy prices and solar-sector valuation. It does not by itself establish direct technological substitution because oil prices may also capture global demand, inflation, commodity-market sentiment, and common energy risk.

Second, the positive coefficient on prior-month revenue growth is statistically significant only at the 10% level. It therefore provides marginal evidence that monthly revenue announcements contain valuation-relevant information for solar-stock returns. The result should be interpreted as limited predictive association rather than strong or causal responsiveness.

Third, the absence of a statistically identifiable regime difference indicates that stronger renewable-energy policy emphasis did not automatically generate a common stock-valuation regime across the sampled firms. This result is consistent with heterogeneous implementation,

profitability, and investor expectations, but it does not establish a causal gap between policy ambition and implementation.

Fourth, the conditional RSS-minimizing date is December 2020, but the bootstrap threshold test does not reject linearity. December 2020 is therefore an exploratory partition and not an identified structural breakpoint.

Based on these findings, the following policy recommendations are proposed. Governments seeking to support the solar energy sector should provide more predictable and concrete financial incentives, such as tax relief or favorable financing mechanisms. Greater transparency in revenue disclosure—through standardized and timely reporting—is crucial for strengthening investor confidence. Moreover, establishing a cross-ministerial energy policy coordination platform would ensure coherence among economic, environmental, and industrial goals. Finally, it is essential for policymakers to routinely assess the effectiveness of current green energy strategies and make evidence-based adjustments to maximize their intended market impact.

## **IV. Discussion**

### **A. Political alternation and policy implementation**

The central finding is not that political alternation is economically irrelevant, but that the reported specification does not identify a discrete change in solar-stock return formation. Political turnover changes policy agendas immediately, whereas investment approval, grid connection, financing, production adjustment, and profitability respond with heterogeneous lags. A single political date may therefore be too coarse to generate a common valuation regime across firms.

### **B. Revenue quality and solar-firm valuation**

The positive full-sample revenue coefficient indicates that monthly revenue announcements contain valuation-relevant information. Its negative sign in the exploratory later period is consistent with a decline in revenue quality: sales expansion can coincide with falling margins, excess capacity, input-cost pressure, or low-margin policy-supported projects. Because the model

does not directly include margins, subsidies, or implementation intensity, these channels should be treated as explanations for future testing rather than established mechanisms.

### **C. Oil prices and common market conditions**

The oil-price coefficient should likewise be interpreted as a market association rather than direct technological substitution. Oil prices may proxy for global demand, inflation, commodity-market sentiment, or broad energy risk. Controlling for common financial and macroeconomic factors is therefore essential before assigning the coefficient a renewable-energy-demand interpretation.

### **D. Generalizability beyond Taiwan**

Taiwan offers an informative democratic energy-transition setting, but the unbalanced panel consists of six long-listed photovoltaic manufacturers. The results therefore generalize most directly to comparable listed, policy-sensitive manufacturers and not to the welfare effect or overall effectiveness of Taiwan's renewable-energy policy. This distinction is important because installed capacity, industrial profitability, investor valuation, and social welfare are different policy outcomes.

## **V. Conclusion**

Political regimes and economic outcomes are often intertwined, with stock markets serving as a real-time reflection of economic sentiment and policy impacts. When administrations with differing policy agendas alternate in power, firms within the same industry may face contrasting regulatory environments. This study investigates whether such political alternation—specifically between the KMT and DPP in Taiwan—has statistically significant effects on the stock returns of solar energy firms.

Focusing on six publicly listed Taiwanese solar companies, we analyze monthly panel data from June 2008 to June 2024. Our key variables include: (1) solar-stock returns (*rst*), as the dependent variable; (2) international oil-price growth (*opg*); and (3) firm-level revenue growth (*rvg*). All variables are log-transformed and first-differenced to ensure stationarity and mitigate the risk of spurious regression.

The empirical model is based on Hansen's (1999) Panel Threshold Model (PTM), using time as the threshold variable to detect structural changes over the sample period. The threshold test identified December 2020 as a potential breakpoint. However, the likelihood ratio statistic did not exceed critical values, indicating no statistically significant threshold effect. Accordingly, we fail to reject the null hypothesis of linearity. The evidence does not identify December 2020 as a structural break, and the exploratory subsample estimates should not be interpreted as political-regime effects.

The full-sample estimates indicate a positive association between oil-price changes and solar-stock returns and comparatively weaker positive evidence for lagged revenue growth. The insignificant threshold test does not identify a structural change coinciding with or following the 2016 political alternation; therefore, H1 is supported, H2 receives weaker support, and H3 is not supported.

The reported evidence does not identify a statistically significant change in the return-generating process associated with political alternation. This should not be interpreted as proof that renewable-energy policy was ineffective. Stock returns capture investor valuation, whereas installed capacity, industrial profitability, implementation quality, and social welfare are distinct outcomes. The results instead indicate that political turnover alone is insufficient to establish a common valuation regime across heterogeneous solar firms.

This study is limited by its six-firm unbalanced panel and its focus on stock returns, oil-price changes, and revenue growth. Future research can extend the analysis through a direct post-2016 interaction model; profitability, subsidy, market-return, interest-rate, exchange-rate, and policy-implementation controls; and cross-sectional-dependence, event-window, and leave-one-firm-out diagnostics. Such extensions would help distinguish political transmission from global shocks and firm-specific restructuring.

## **Data availability**

The datasets and supporting analysis files are supplied as supplementary materials for confidential peer review: data\_sunpower.xlsx (study dataset), 20250123\_outcome.xlsx (EViews estimation and diagnostic output), and new\_sunpower.wfl (EViews workfile containing the source series, transformed variables, model objects, and estimation history). Stock-price and firm-revenue data were obtained under licence from the Taiwan Economic Journal (TEJ); monthly firm revenue is also available from Taiwan's Market Observation Post System (MOPS), while WTI and Brent crude-oil price series were retrieved from Yahoo Finance. Because the files incorporate TEJ-licensed data, they are provided solely for confidential assessment by the editors and referees and must not be redistributed publicly. Supplementary File 1 provides the data dictionary, firm and ticker list, transformations, source and sample information, and reproducibility workflow.

## **Code availability**

The EViews workfile new\_sunpower.wfl, the empirical output file 20250123\_outcome.xlsx, and the documented model formulae, variable transformations, estimation sequence, and bootstrap threshold workflow in Supplementary File 1 are supplied for confidential peer review and editorial verification.

## **Author contributions**

Author 1 contributed to conceptualization, data curation, investigation, and original drafting. Author 2 contributed to conceptualization, methodology, formal analysis, supervision, and manuscript revision. Both authors reviewed and approved the final manuscript.

## **Competing interests**

The authors declare no competing interests.

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## Ethical Approval

This article does not contain any studies with human participants performed by any of the authors.

## Informed Consent

Informed consent was not applicable.

## Supplementary Files

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